

## REMARKS

Reconsideration of the above-identified application is respectfully requested.

Claims 1-2, 4-9, 21-22, 25-38, and 40-45 remain in this application. Claims 24 and 39 are canceled herein, and claims 3, 10-20, and 23 were previously canceled. Claims 1, 4, 5, 9, 21, 25-27, 29, 31, 33-34, and 37-38 have been amended and claims 40-45 have been added to more particularly point out and distinctly claim the subject matter that Applicants regard as their invention and to place the claims in better position for appeal. Support for the amendments can be found on page 12, lines 12-19 of the specification. Additional support for the amendment to claim 5 can be found on page 12, line 20 through page 13, line 11. Additional support for the amendment to claim 9 can be found on page 29, lines 10-14, Figure 8, and Table 2. Support for new claim 40 can be found on page 12, line 12 through page 13, line 9; page 25, lines 7-9; page 29, lines 10-14, Figure 8, and Table 2; and in Examples 19, 21, and 25. Support for new claims 41 and 42 can be found on page 12, line 21 through page 13, line 9. Additional support for new claim 41 can be found in Examples 15-21. Support for new claims 43-45 can be found on page 17, line 22 through page 18, line 4 and in Examples 26-30. No new matter has been added.

I. Claim 39 as an independent or distinct claim

Claim 39 was allegedly directed to an invention that is independent or distinct from the invention originally claimed. Therefore, the Examiner withdrew claim 39 from consideration. Applicants have canceled claim 39.

II. Rejection under 35 U.S.C. § 112, first paragraph

Claims 5, 24, 26 and 37 were rejected under 35 U.S.C. § 112, first paragraph, as failing to comply with the written description requirement. The written description requirement is satisfied

when a patent specification describes the claimed invention in sufficient detail that one skilled in the art can reasonably conclude that the inventor had possession of the claimed invention. See, e.g., *Vas-Cauth, Inc. v. Mahurkar*, 935 F.2s 1555, 1563 (Fed. Cir. 1991). Regarding claim 24, the Examiner stated that he could not find basis in the specification for the upper limitation of 2000 nm. Although claim 24 has been canceled, Applicants will address this rejection since the limitation of claim 24 has been incorporated into independent claim 21. Page 20, lines 19-20, of the specification specifically states that “typical MIME device film thickness is 5 to 10,000 nm.” It is clear from the specification that any film thickness in this range is acceptable. Since 2,000 nm falls within this range, Applicants respectfully submit that the specification describes the claimed invention in sufficient detail that one skilled in the art can reasonably conclude that the inventors had possession of the claimed invention.

Regarding claims 5 and 26, the Examiner was not able to find basis for the specificity that the various molecules have been defined. Applicants have amended claims 5 and 26 to remove the specificity added in the previous amendment. Amended claims 5 and 26 clearly comply with the written description requirement because page 12, line 20 through page 13, line 9 states the following:

The ligand shell can be a monomolecular or multimolecular layer. The ligand shell substance is advantageously a functionalized organic compound, such as a thiol, or an amine. These thiols can be primary aliphatic thiols (preferably straight chain or branched), secondary aliphatic thiols, tertiary aliphatic thiols, aliphatic thiols substituted heterofunctionally (for instance, by OH, COOH, NH<sub>2</sub>, Cl, and the like, preferably HS(CH<sub>2</sub>)<sub>6</sub>OH or the hexafluoroacetone adduct) aromatic thiols, aromatic thiols substituted heterofunctionally (for instance, by OH, COOH, NH<sub>2</sub>, Cl, and the like, preferably HS(CH<sub>2</sub>)<sub>6</sub>OH or the hexafluoroacetone adduct) and araliphatic thiols substituted heterofunctionally (for instance, by OH, COOH, NH<sub>2</sub>, Cl, and the like, preferably HS(CH<sub>2</sub>)<sub>6</sub>OH or the hexafluoroacetone adduct).

Regarding claim 37, the Examiner could not find basis for the “and combinations thereof” portion of the claim. Applicants have amended claim 37 to remove this language.

Based on the above, Applicants respectfully submit that claims 5, 21 (as amended to incorporate the limitations of claim 24), 26, and 37 comply with the written description requirement.

III. Rejection under 35 U.S.C. § 112, second paragraph

Claims 1-2, 4-9, 21-22, and 24-38 were rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention. The claim language “and composed of an encapsulating monomolecular layer of ligand molecules each molecule having a single bonding site to a gold surface” contained in each independent claim allegedly creates confusion.

The Examiner first points out that the claims have particles that have a core of a conductive metal or conductive metal alloy, but do not limit this to gold. Thus it is not clear if Applicants intend to limit the particles to gold particles or alloys. Applicants do not intend to limit the metallic core to gold or a gold alloy. Claims 1, 9, 21, 25, 27, 29, 31, and 33-34, have been amended to remove the “single bonding site to a gold surface” and to clarify that each ligand molecule has a head-tail type structure, the head being a functional group possessing a bonding interaction with metal atoms in the core surface, and the tail having a structure and composition designed to provide additional stabilization of metal clusters against irreversible agglomeration, induce solubility in solvents, and promote interactions with chemical species of interest.

Then the Examiner states that in the heterofunctional molecules there are functional groups such as NH<sub>2</sub> that present a second gold surface bonding site and that portion of those claims fails to further limit the independent claims. Again, claims 1, 9, 21, 25, 27, 29, 31, and 33-34, have been amended to remove the “single bonding site to a gold surface” and to clarify

the head-tail type structure of the ligand molecules. In the specification, verbiage pertaining to ligand shell molecules is cited in several instances as follows. On page 12, line 12 through page 13, line 11, the specification states:

The ligand molecule typically has a head-tail type structure; the head is a functional group possessing a bonding interaction with metal atoms in the core surface, and the tail has a structure and composition designed to provide additional stabilization of metal clusters (i.e. core bodies) against irreversible agglomeration, induce solubility in solvents and promote interactions with chemical species of interest. The ligand shell can be a monomolecular or multimolecular layer. The ligand shell substance is advantageously a functionalized organic compound, such as a thiol, or an amine. These thiols can be primary aliphatic (preferably straight chain or branched), secondary aliphatic thiols, tertiary aliphatic thiols, aliphatic thiols substituted heterofunctionally (for instance, by OH, COOH, NH<sub>2</sub>, Cl, and the like, preferably HS(CH<sub>2</sub>)<sub>6</sub>OH or the hexafluoroacetone adduct) aromatic thiols, aromatic thiols substituted heterofunctionally (for instance, by OH, COOH, NH<sub>2</sub>, Cl, and the like, preferably HS(CH<sub>2</sub>)<sub>6</sub>OH or the hexafluoroacetone adduct) and araliphatic thiols substituted heterofunctionally (for instance, by OH, COOH, NH<sub>2</sub>, Cl, and the like, preferably HS(CH<sub>2</sub>)<sub>6</sub>OH or the hexafluoroacetone adduct). Preferred amines are primary aliphatic amines. The aliphatic portions of such thiols and amines can be of from 3 to 20 carbon atoms, especially 4 to 16 carbon atoms.

It is explicitly stated in this head-tail depiction of the ligand molecule that the head portion of the molecule functions as a bonding site to the metal atoms in the core surface, and that the tail portion functions to stabilize the nanoparticulate metal cores against irreversible agglomeration, induce solubility and to promote interactions with chemical species of interest. Regarding the tail portion of the ligand molecule, it is further explicitly stated that the structure and composition may be primary, secondary, tertiary aliphatic, may be aromatic and may incorporate heterofunctionality (i.e. alcohol, carboxylic acid, amine, halogen, etc., i.e. substructures whose composition is not limited to carbon or hydrogen). Nowhere is it stated, implied or intended that the tail portion of the ligand molecule can assume the function of the head portion of the ligand molecule which is a bonding interaction with metal atoms in a core

surface. The Examiner has erroneously read this possibility into our specification when interpreting our claims.

On page 25, lines 4-13, the specification states:

Sensitivity can also be chemically modulated by introduction of a heterofunctionality to the ligand shell or by adding a binder with heterofunctionality just prior to the deposition of the film. The heterofunctionality is a heteroatom functional group such as amine, hydroxyl, halogen, phosphoryl, carboxy, ether, etc. In the former case, the ligand molecule is then bifunctional, one functional group to bind with the metal core surface and the other to provide an attractive interaction for sorption of target species.

This text further demonstrates that the intent of a second added heterofunctionality is for the purpose of interacting with a target species to be detected and not functioning as a group that will bind to a metal core surface.

Examples 17, 18, 19, 20, 21, and corresponding entries in Tables 1 and 2 illustrate functionality incorporated into the tail of the ligand molecule, i.e. in Example 17 the tail portion is a benzyl araliphatic functionality, in Example 18 the tail portion is a phenethyl araliphatic functionality, in Example 19 the tail portion is a 4-methoxybenzyl araliphatic ether heterofunctionality, in Example 20 the tail portion is a phenyl aromatic functionality, and in Example 21 the tail portion is a 4-hydroxyphenyl aromatic heterofunctionality. Examples 15 and 16 document a basis for the tail of ligand molecule having a branch chain structure. Example 25 further demonstrates what is meant by heterofunctionality wherein a binder is composed of hydroxyl, ether, trifluoromethyl and phenyl functionalities.

Referring to page 24, lines 6-16 and the upper plot of Figure 9:

The upper plot presents the toluene vapor response (at a vapor concentration corresponding to  $P/P_0 = 0.1$ ) of devices prepared with three homologous series of clusters having constant metal core radii (determined by the (X:Y) where (1:1), (3:1) and (5:1) correspond to 1.11 nm, 1.57 nm and 2.97 nm, respectively) and varying ligand shell thickness. The maxima of this plot show that each metal core size has an optimum ligand shell thickness for highest sensitivity. This maximum

sensitivity gradually diminishes as one progresses to homologous series of larger radii.

This text and figure demonstrate the importance of an optimum shell thickness for the sensing application and represent the basis for selecting ligand molecules with chain lengths providing shell thicknesses that cover these ranges. These molecular chain lengths range from 4 to 16 atoms. This unique teaching from the specification is not found or inferred from external references.

Referring to page 23, lines 14-19, Figure 8, Examples 1 and 21, and Table 2:

Figure 8 compares the sensitivity of the device to a variety of other vapors. Of great significance is the extraordinarily low response to water vapor which is essential for practical application in which trace levels of organic vapors must be detected and monitored in humid ambient air.

This text, figure, example and table demonstrate the basis in the specification for target species detection selectivity and the role that heterofunctionality in the tail portion of the ligand molecule can play. When the simple non-heterofunctionalized octanethiol is used as the ligand molecule, an insensitivity to a water vapor target is obtained, however, when the 4-hydroxythiophenol is used as the ligand molecule (Example 21 in Table 2) the sensor responds strongly to the water vapor target and the response is in the direction of increasing rather than decreasing conductivity. This unique teaching from the specification is not found or inferred from external references.

Regarding the Examiner's specific objection regarding NH<sub>2</sub> being present, the sulfur in the head portion of the ligand molecule has a much stronger interaction with the metal surface and would displace the amine which is relegated to the tail portion of the ligand molecule. This bond strength difference and facile displacement by a thiol of an amine on a gold surface is well known to those skilled in the art.

Based on the above, Applicants respectfully submit that claims 1-2, 4-9, 21-22, and 23-38 are not indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as their invention.

IV. Rejection under 35 U.S.C. § 102(b) –Bethell

Claims 1-2, 4-5, 7-9, 21-22, 24-27 and 33-34 were rejected under 35 U.S. C. 102(b) as being anticipated by Bethell (*J. Electroanal. Chem.*, 409, 137 (1996)). To be anticipating, a reference must disclose every element of the claims. *Scripps Clinic & Res. Found. v. Genentech, Inc.*, 927 F.2d 1565, 1576 (Fed. Cir. 1991); *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236 (Fed. Cir. 1989). If the reference lacks any claimed element, there is no anticipation. *Kloster Speedsteel AB v. Crucible Inc.*, 793 F.2d 1565, 1571 (Fed. Cir. 1986).

Bethell does not teach or disclose a ligand shell “of thickness from 0.4 to 4.0 nm” as recited in independent claim 1 (from which claims 2 and 4-5 and 7-9 depend), independent claim 21 (from which claim 22 depends), independent claim 25 (from which claim 26 depends), independent claim 27, independent claim 33, and independent claim 34. According to the specification (page 13, lines 12-17) of the present application, “[t]he shell is advantageously neither so thin that the multiplicity of particles is effectively metallic in its conductivity properties, nor so thick that the multiplicity of particles is completely electrically insulating. Preferably, such thickness ranges from 0.4 to 4 nm, especially 0.4 to 2.5 nm.” According to the Examiner, “Page 138, column 1, last full paragraph [of Bethell] teaches nonanethiol derivatized particles having a core diameter of 1.5-3 nm,” while this paragraph of Bethell actually states that “the metal particles had a narrow range of diameters in the range 1.5 to 3 nm.” The Bethell reference does not use the word “core” or the word “shell.” By changing the Bethell word “particles” to the word “core” with the attendant implication that the “shell” counterpart of the

invention is equivalent or anticipated by Bethell in his office action, the Examiner is reading information into the Bethell reference that is not there. Although Bethell discusses particle core size, Bethell does not teach or disclose particles with a ligand shell of the required thickness. Therefore, Bethell does not anticipate claims 1-2, 4-5, 7-9, 21-22, 25-27, and 33-34.

Additionally, Bethell does not teach or disclose “a ligand shell . . . composed of an encapsulating monomolecular layer of ligand molecules each molecule having a head-tail type structure” as recited in amended independent claim 1 (from which claims 2, 4-5 and 7-9 depend), amended independent claim 21 (from which claim 22 depends), amended independent claim 25 (from which claim 26 depends), amended independent claim 27, amended independent claim 33, and amended independent claim 34. Bethell uses the words “organic spacer” (page 137, top of right column) to describe the function of the organic components, which serves as “matrices” to embed metal particles (page 137, left column line 5) in his study. The Bethell concept for the “nonanethiol” and the “dodecanethiol” is that of a fixed organic spacer of different lengths, while the concept of the present invention is that of a monomolecular layer whose absorption and desorption of vapors results in a dynamic measurable property change. Bethell uses dithiols with bare clusters only for the purpose of providing an organic spacer or linker between neighboring gold particles as a way of making three-dimensional networks. Monothiols are not used by Bethell because they do not perform this function. In the present application, monothiols and other monofunctional ligand molecules are used to absorb analyte molecules.

The Examiner assets that there is a “significant similarity” between examples 26-30 of the present application and the process described by Bethell to form a self-assembled layered structure. Examining the details of Bethell reveals that a monofunctional alkanethiol (e.g. nonanethiol or dodecanethiol) is not used at all, and the clusters employed are those without the

alkanethiol shell. In examples 26-30, all of the clusters have both a gold core and an alkanethiol shell. This difference is significant as it requires knowledge that a ligand exchange action will occur for layered deposition of self assembled clusters. Bethell does not teach this knowledge.

Bethell uses dithiols and bare clusters (i.e. clusters without shells), while the present application teaches monofunctional ligand molecules to form the shell and the use of clusters with preformed shells in the synthesis of the self-assembled film. The specification of the present application clearly excludes dithiol for use in the ligand shell. The Bethell reference uses the descriptive term “organic spacer” and fails to use either “ligand” or “shell.” The “organic spacer” of Bethell serves a different function than that of a ligand shell.

Moreover, Bethell’s disclosure is not an electrical configuration for a sensing device and does not teach or disclose an article of manufacture, an assembly, or a system “capable of interacting with a chemical species in a target environment such that an electrical property of said multiplicity of particles is altered,” as recited in independent claims 1, 21, 25, 27, 33 and 34.

The objective of Bethell is stated on page 137, col. 1-2:

Our intention was to develop materials in which it would be possible to control the transfer of electrons from one metal particle to another by controlling the size of the particles, their separation and, we hoped, the chemical nature of the organic spacers providing that separation. We had in mind particularly the possibility that, by incorporating into the spacers organic moieties that could be addressed electrochemically or photochemically, we could go some way towards the construction of electronic circuitry of a size range approaching the molecular.

The focus of Bethell is on using only dithiols to link large bare clusters together for electronic circuitry. Throughout the reference, Bethell stays focused on its objective and in no way infers, speculates, or provides any means for anticipating that metal (gold or otherwise) nanoparticles with an appropriate ligand shell could be used for chemical detection as described in the claims of the present application. In fact, in the last paragraph of the conclusion on page 143, Bethell

speculates that “there are many applications for the nanostructured materials that have been described here. These range from submicroelectronic devices and circuitry (switches, diodes, electrochromics and photovoltaics) to electrical modification of the reflectance of glass.” Chemical sensors are not included in Bethell’s range of applications, and the configuration of this range of devices is not what one of ordinary skill in the art would select for a chemical sensor. Bethell does not teach an article of manufacture, an assembly, or a system “which is capable of interacting with a chemical species in a target environment such that an electrical property of said multiplicity of particles is altered” as recited in the amended claims of the present application.

Therefore, Bethell cannot anticipate claims 1-2, 4-5, 7-9, 21-22, 25-27, and 33-34.

V. Rejection under 35 U.S.C. § 102(b) –Andres

Claims 1-2, 4-5, 7-9, 21-22, 24-27, and 33-34 were rejected under 35 U.S.C. § 102(b) as being anticipated by Andres (“Self-Assembly of a Two-Dimensional Superlattice of Molecularly Linked Metal Clusters,” *Science*, Vol. 273, 1690-1698 (1996)).

The intent of Andres’ work was to explore a chemical self-assembly fabrication process that has relevance for nanoelectronic digital circuits. The design was to generate a two-dimensional planar array of regularly spaced metal nanoparticles of uniform size interconnected by rigid rod conjugated organic molecules. The approach was to prepare the bare clusters by gold evaporation and condensation, anneal to obtain a uniform size, coat with a dodecanethiol adsorbed monolayer to obtain a solubilized cluster in aromatic solvents, spin coat from solution to obtain a monolayer array of regularly spaced dodecanethiol encapsulated gold particles, displace all of the adsorbed dodecanethiol molecules with rigid rod molecular wire interconnecting molecules (aryl dithiol or di-isonitrile molecules), and conduct electrical

measurements with a contacting electrode configuration that minimized the number of clusters in the electron transport path. TEM micrograph of monolayers of metal particle networks and nonlinear current-voltage characterization results are presented as evidence for the monolayer array fabrication and Coulomb blockade quantized effects on electron transport.

Andres does not teach or disclose a three dimensional assembly as recited in independent claim 1 (from which claims 2, 4-5 and 7-9 depend), independent claim 21 (from which claim 22 depends), independent claim 25 (from which claim 26 depends), independent claim 27, independent claim 33, and independent claim 34. The present application clearly teaches a three-dimensional assembly of particles in close-packed orientation deposited onto a contacting electrode with varying degrees of coating thickness depending on the deposition method. In contrast, Andres goes to great lengths to accentuate the monolayer character of his deposition. Andres' teaching is limited to a "two-dimensional", "planar array" of metal particles. This teaching is reiterated many times in the Andres reference as evidenced by the following terms: "planar arrays" (abstract, p. 1690), "cluster monolayer" (abstract, p. 1690), "adjacent clusters in the monolayer to form a two dimensional superlattice of metal quantum dots" (abstract, p. 1690), "planar array of small metal islands" (middle column, p. 1690), "two-dimensional (2D) superlattice of uniform metal nanocrystals" (left column, p. 1691), "monolayer film of these coated particles" (left column, p. 1691), and "close-packed monolayer arrays" (page 1692).

Additionally, Andres does not teach or disclose a ligand shell "composed of an encapsulating monomolecular layer of ligand molecules each molecule having a head-tail type structure, the head being a functional group possessing a bonding interaction with metal atoms in the core surface, and the tail having a structure and composition designed to provide additional stabilization of metal clusters against irreversible agglomeration, induce solubility in solvents,

and promote interactions with chemical species of interest” as recited in amended independent claim 1 (from which claims 2-5 and 7-9 depend), amended independent claim 21 (from which claims 22-24 depend), amended independent claim 25 (from which claim 26 depends), amended independent claim 27, amended independent claim 33, and amended independent claim 34. There is an important issue with regard to the nature of the ligand molecule interaction with the gold surface of the cluster core. With specific regard to employment of an alkyl thiol (dodecanethiol), Andres teaches the following (bold font added for later referral): “... a surfactant that rapidly **adsorbs** onto the surface of the clusters and prevents aggregation. A number of molecules have been found effective in this regard, including fatty acids, alkyl thiols, alkyl disulfides, alkyl nitriles, and alkyl isonitriles.” (page 1691, bottom of right column); “... 1- to 5-nm diameter gold clusters **encapsulated** by 1-dodecanethiol are stable in mesitylene or decane for more than 6 months.” (page 1692, left column); “... dodecanethiol-**encapsulated** gold clusters ...” (Fig. 3 caption); “... the clusters are **surrounded** by a monolayer film of dodecanethiol.” (page 1692, middle column). This verbiage (particularly use of the words adsorb, encapsulate, surround) is not equivalent to the teaching of claims 1, 21, 25, 27, 33 and 34 where, as expressed above, an “encapsulating monomolecular layer of ligand molecules each molecule having a head-tail type structure, the head being a functional group possessing a bonding interaction with metal atoms in the core surface, and the tail having a structure and composition designed to provide additional stabilization of metal clusters against irreversible agglomeration, induce solubility in solvents and promote interactions with chemical species of interest” is taught. Andres’ verbiage significantly changes when referring to the use of the aryl dithiol and aryl di-isocnitrile molecules: “... it is possible to **covalently link** the clusters to each other using double-ended molecular interconnects ...” (page 1692, middle column); “Aryl dithols

and di-isocyanides completely displace alkyl thiols from a Au(111) surface to form SAMs in which only one end of the molecule is **attached to the gold substrate** (12). These molecules also displace dodecanethiol from the gold clusters in an unlinked array and interconnect neighboring clusters to produce a **covalently linked** network.” (page 1692, right column). This latter verbiage indicates Andres teaches chemical bonding of aryl dithiols to the gold surface of a cluster, while Andres earlier verbiage above teaches adsorption absorption of alkyl thiol to the gold surface. The interactions of the aryl and alkyl thiols toward the gold surface are clearly different. Andres does not teach chemical bonding of the monofunctional alkyl thiol to the gold surface but does teach that the aryl thiol aggressively displaces alkyl thiol and bonds to the gold surface. Further, Andres teaches nothing about a free alkyl thiol or dithiol displacing an already adsorbed alkyl thiol from a gold cluster surface. Regarding the synthetic method to produce clusters, the Examiner states, “In the last full paragraph of the center column of page 1691, Andres teaches that the synthetic method used produces particle that are equivalent to those produced by the Brust method (see reference 5).” Andres actual wording here is, “... nanoparticles produced by this method are equivalent in quality ...” to the Brust method. What is meant by the words “equivalent in quality” is neither qualified nor defined.

Moreover, Andres’ disclosure is not an electrical configuration for a sensing device and does not teach or disclose an article of manufacture, an assembly, or a system “capable of interacting with a chemical species in a target environment such that an electrical property of said multiplicity of particles is altered,” as recited in independent claims 1, 21, 25, 33 and 34. Andres teaches the use of a large conjugated rigid rod double-ended molecular interconnect between metal particles with a molecular wire function (i.e. aryl dithiol or di-isocyanide molecules, page 1692, middle column) which is consistent with the stated objective of the

reference, i.e., a proposed future basis for nanoelectronic digital circuits (page 1690, third column). However, this is not the case for an invention involving chemical sensing where flexible coiled up chemical structures of the ligand shell molecules and of any intercluster self-assembly coupling agents is taught, and this is important in order to accommodate sorption of and swelling by analyte molecules. The resulting modulation of the distance between metal cores and of the dielectric character of the medium between cores caused by vapor absorption is central to the transduction for the sensing application but would have a detracting role in nanoelectronic circuitry.

In Andres, the number of metal particles involved in the electron transport measurement is minimized in order to obtain the nonlinear Coulomb blockade current voltage measurement. In the configuration normal to the planar array of particles, the contacting measurement is made by an STM probe through a single cluster (page 1692, third column), while in the configuration parallel to the planar array of particles, the contacting measurement is made by a thin (40-50 nm wide) line metal deposition with a 450 nm gap. In this planar configuration the current flows through a minimal number of individual clusters with a nonlinear dependence on voltage (page 1692-1693 and figure 5). In the present application, a planar configuration is used with an interdigital electrode. This maximizes the number of clusters through which electron transport occurs, provides greater signal to noise ratio in the form of higher measured currents and a simpler and more useful linear current-voltage dependence.

In summary, the features Andres' structure include a material makeup of a rigid rod linked cluster array, a constraining of the cluster array to two dimensions and a contacting electrode design that minimizes the number of clusters through which charge transport occurs.

All of these features work toward making that overall structure inert to sensing the presence of any chemical species in its environment.

Therefore, Andres cannot anticipate claims 1-2, 4-5, 7-9, 21-22, 25-27, and 33-34.

VI. Rejection under 35 U.S.C. § 103(a) –Bethell in view of Natan

Claims 2, 4, 6, and 22 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Bethell as applied to claims 1 and 22 above, and further in view of U.S. Patent 5,609,907 to Natan. To establish a *prima facie* case of obviousness, the Examiner must show that one of ordinary skill in the art would have been motivated by the prior art to fashion an embodiment satisfying all claim limitations. *In re Royka*, 490 F.2d 981 (C.C.P.A. 1974); M.P.E.P. 2143.03.

Like Bethell (as discussed above in section IV of this Amendment), Natan fails to disclose a ligand shell with a thickness from 0.4 to 4 nm. The assemblies disclosed in Natan use large bare gold clusters that physisorb proteins such as streptavidin to achieve the non-covalent attachment of metal core particles. The proteins are very large molecules and, if used to coat a metal particle, would generate a shell so thick that each particle would be insulated from another and electron transport would not be measurable. Therefore, the hypothetical combination of Bethell and Natan does not disclose every claim limitation and, thus, does not render obvious claims 2,4, 6 and 22.

Moreover, like Bethell (as discussed above in section IV of this Amendment), Natan does not disclose an article of manufacture or an assembly for use in determining whether or in what amount a chemical species is present in a target environment. The scope of Natan is limited to the preparation of self-assembled metal colloids as monolayer depositions primarily for the purpose of surface enhanced Raman spectroscopy (SERS) analytical applications. In Natan's abstract, other applications are suggested (e.g., biocompatible surfaces, catalysts, nonlinear optics and electrochemical applications), but all prescriptions for depositions of metal colloids

use bare gold clusters and conform with a procedure dedicated to the SERS application. The scope and content of the art described in Natan is focused on the SERS application, which allows for optical sensing but not electronic sensing, and cannot accommodate an extension to a chemical sensing application as recited in the claims of the present invention.

Therefore, the hypothetical combination of Bethell and Natan cannot render obvious claims 2, 4, 6 and 22.

#### VII. Rejection under 35 U.S.C. § 103(a) –Bethell in view of Terrill and Andres

Claims 27 and 29-32 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Bethell as applied to claims 1-5, 7-9, 21-26, and 33-34 above, and further in view of Terrill (*J. Amer. Chem. Soc.*, 117, 12537 (1995) and Andres.

Like Bethell (as discussed above in section IV of this Amendment) and Andres (as discussed above in section V of this Amendment), Terrill is not an electrical configuration for a sensing device and does not teach or disclose a method of fabrication “capable of interacting with a chemical species in a target environment such that an electrical property of said multiplicity of particles is altered,” as required by independent claim 27 (upon which claims 29-32 depend). The electrical conductivity measurements in Terrill were made in a vacuum, which shows no anticipation of a sensor application. Moreover, in Terrill, electrical conductivity measurements were made using very thick coatings. The coating deposition method of Terrill is a drop casting technique using a solution with a 100 mg/mL concentration that produces coatings of 2-20  $\mu\text{m}$  thick, which is many times thicker than the height of the electrode. (Terrill last paragraph on page 12538) In the present application, it is explicitly stated that this technique is not adequate for a chemical sensing application and that acceptable “thin” film deposition

techniques include spraying fine mist of a dilute solution onto a preferably heated substrate surface and chemical self assembly. (Page 17, line 8 through page 19, line 2)

Therefore, the hypothetical combination of Bethell, Terrill, and Andres cannot render obvious claims 27 and 29-32.

**VIII. Comments on Examiner's statement regarding consideration of Applicants' arguments**

Applicants request that Examiner fully consider all of Applicants arguments. The Examiner stated in paragraph 12 on page 8 of the Office Action mailed on June 2, 2004, that Applicant's arguments were fully considered. However, in lines 1 and 2 on page 9 of the above-referenced Office Action, the Examiner stated that "the recitation of a chemical species has not been given patentable weight because the recitation occurs in the preamble." However, Applicants had previously amended the claims so the recitation of a chemical species was in the body of the claim. Additionally, in lines 11-13 on page 9 of the above-referenced Office Action, the Examiner stated that "Claim 1 is of a scope that encompasses much more than electrically sensing a chemical of interest." However, Applicants had previously amended the claims to state that "the ligand shell [is] capable of interacting with a chemical species in a target environment such that an electrical conductivity property of said multiplicity of particles is altered." Therefore, it is unclear whether the Examiner fully examined the amended claims.

The Examiner concludes that thickness of the coating is an inherent property since Bethell uses the same materials as in the instant specification. Based on the context of the Examiner's rejection and the use of the word "coating" in Bethell on page 137, the Examiner's use of the word "coating" is assumed to be synonymous with shell. Applicants respectfully submit that thickness of the coating is not an inherent property. The thickness of the coating is a feature of the structure determined by the chain length of the ligand molecule and each particle

or cluster (as defined on page 11-13 in the specification as having a metal core and a shell of ligand molecules the thickness of which is determined by the size of the ligand molecule). Thus, changing the ligand molecule of a particle changes its structure. The Applicants further submit that, connected with the chemical sensor application, the materials taught by Behell, Andres, and the instant specification are not the same since, based on the information provided, it is not possible to determine whether they have precisely the same shell composition, structure, and thickness and the same core size and size distribution. Figure 9 and Table 2 of the specification make it clear that the interaction with chemical species is dependent on these features, thus making it necessary to include this property in the claims.

The Examiner also concludes that “the interaction with a chemical species is an inherent property of the material being used to interact with the species.” Applicants respectfully submit that interaction with a chemical species is not an inherent property. The specification teaches a variety of particle structures having different ligand molecules in their shells (ligand molecules with a range of chain lengths, branch chain ligand molecule structures, araliphatic ligand molecule structures, heterofunctional groups incorporated into ligand molecule structures). The interaction of a chemical species varies substantially as the structure of the ligand shell varies (see Table 2 of the specification where examples show interactions ranging from strong interactions to practically no interaction as well as positive and negative responses to these interactions) and not necessarily in a predictable manner. Thus, the interaction with a chemical species is unpredictable and needs specification. Hence, it is an important descriptor of the material.

Further, the Examiner states, “... the Natan reference is used to show that other types of ligands and metals can be used to form particles. The obviousness is based on the similarity of

the methods and the final products.” As pointed out previously in Section VI, all of Natan’s particles (or colloids as the Natan reference calls them) are bare metal particles without a shell of ligand molecules. The bare metal particles are necessary for the SERS optical measurement of the Natan invention but are unworkable in the invention described in the specification. Thus, it is incorrect for the Examiner to state a similarity in final products.

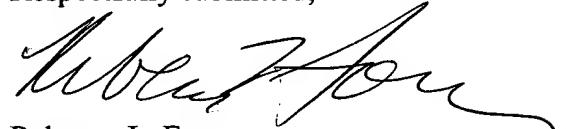
Additionally, the Examiner states that there is overlap in ranges of deposited film thickness taught by Terrill and with that taught by Andres and Bethell. The Examiner does not state what he thinks are the film thickness ranges taught separately by Terrill, Andres and Bethell. The Terrill range is 2-20 microns as previously stated and documented in Section VII. The 2-20 micron range has little or no value to the invention, and Claim 21 was modified to a 0.005 to 2 micron range any perceived basis for objection. Regarding Andres and Bethell as previously pointed out, their methods result in a different material being deposited. Bethell’s method of deposition employs bare clusters and dithiols and results in a deposited material where only dithiol spacers interconnect the gold surfaces of the particles. Ligand shells of the specification consist of ligand molecules that connect to the surface of a single gold core and do not interconnect two gold surfaces. Thus, the material described by Bethell in a deposited film is composed only of dithiol and gold particle, has no ligand shell as defined in the specification and is a different material from that described in the specification. Bethell specifies no film thickness. Andres’ method of deposition employs initially bare gold particles deposited in vacuum that subsequently have dodecanethiol adsorbed onto their surface from solution and are finally deposited as a monolayer of particles using “double ended molecular interconnects” (aryldithiols and aryl di-isocyanides) to displace the dodecanethiol. Andres is explicit that all of the dodecanethiol is displaced and the film thickness is no more than that of a single monolayer

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of particles. Thus again the material deposited by Andres is different from that in the current specification because it has only molecular interconnects between two gold particle surface and no shell of ligand molecules. Further, the thickness limit of Andres' deposited monolayer film is no larger than his particle diameter which is 5 nm and does not overlap that of the current specification. In summary, the materials taught by a combination of Andres and Bethell that can be deposited as thin films either have no ligand shell or lose it in the process of the deposition. In the deposition method of the specification the ligand shell is retained as is necessary for it to have an interaction with chemical species of interest in a target environment resulting in an electrical property of the film being altered. The combination of Andres and Bethell do not make the method taught in the specification obvious because the ligand shell is lost using either one or a combination of both the Andres and Bethell methods whereas the ligand shell is retained when the method in the specification is used.

In view of the foregoing, it is respectfully submitted that this application is ready for allowance. Applicants respectfully request that a timely Notice of Allowance be issued in this case. Kindly charge any additional fees due, or credit overpayment of fees, to Deposit Account No. 50-0281.

Respectfully submitted,



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